



Traumatic Brain Injury Care in the Department of Defense

September 2009

TABLE OF CONTENTS

TRAUMATIC BRAIN INJURY CARE IN THE DEPARTMENT OF DEFENSE	1
1. EXECUTIVE SUMMARY	1
2. OVERVIEW OF TRAUMATIC BRAIN INJURY	3
TBI DEFINITION	3
TBI SEVERITY	4
TBI SIGNS AND SYMPTOMS	4
TBI SCREENING	5
TBI SURVEILLANCE METHODOLOGY	5
TBI CONTINUUM OF CARE IN THE DoD	6
3. TBI PREVENTION.....	6
4. IDENTIFICATION OF TBI: DEPLOYED SETTING.....	7
MILD TRAUMATIC BRAIN INJURY	7
MODERATE TO SEVERE TRAUMATIC BRAIN INJURY	7
5. IDENTIFICATION OF TBI: NON-DEPLOYED SETTING.....	8
MILD TRAUMATIC BRAIN INJURY	8
6. MANAGEMENT OF TBI.....	9
IN-THEATER MANAGEMENT – MILD TBI.....	9
IN-THEATER MANAGEMENT – MODERATE, SEVERE AND PENETRATING TBI	10
NEUROCOGNITIVE ASSESSMENT TOOL (NCAT)	11
NON-DEPLOYED MANAGEMENT – MILD TBI	11
NON-DEPLOYED MANAGEMENT – MODERATE, SEVERE, AND PENETRATING TBI	12
7. TBI EDUCATIONAL INITIATIVES	13
PROVIDER TRAINING.....	13
PATIENT AND FAMILY EDUCATION	14
CARE COORDINATION.....	14
8. EXTERNAL EVALUATION AND RECOMMENDATIONS.....	15
INSTITUTE OF MEDICINE REPORT ON LONG TERM EFFECTS OF TBI (2008)	15
9. SELECTED RESEARCH AND PILOT WORK.....	17
BLAST AND OTHER COMBAT RELATED BRAIN INJURY	17
10. SERVICE SPECIFIC INITIATIVES.....	18
ARMY TBI PROGRAMS.....	18
NAVY AND MARINE CORPS TBI PROGRAMS.....	19
AIR FORCE TBI PROGRAMS	19
11. RECOMMENDATIONS FOR THE WAY AHEAD AND SUMMARY	21
RECOMMENDATIONS FOR THE WAY AHEAD	21
SUMMARY	21
CONTRIBUTORS.....	21

Department of Defense: Traumatic Brain Injury

A Strategic Overview

1. Executive Summary

The Defense Centers of Excellence (DCoE) for Psychological Health (PH) and Traumatic Brain Injury (TBI) and its operational component the Defense and Veterans Brain Injury Center (DVBIC) are very concerned with the prevention, accurate and timely diagnosis, and appropriate management and disposition of Service members with TBI, now and in the future. The long-term consequences of non-mitigated risks associated with TBI pose a serious threat to the over-arching healthcare continuum we provide to our Service members. This healthcare issue when properly addressed will help us to directly and efficiently control the long-term costs of managed healthcare to our nation's Service members. This is a Military Health System/Conservation of Combat Power issue that impacts our national security. The efforts of DCoE align with Force Health Protection initiatives and the National Military Security Strategy of the United States, by preserving our nation's greatest resource: The brave individuals who serve in uniform.

Within the primary components of TBI, there exists a continuum of care ranging from prevention, through early detection, management, reintegration, education, and, in support of these efforts, research. Prevention and research represent the best overall approaches to a solution that will yield the greatest return on investment (ROI). Under development are the state-of-the-art Enhanced Combat Helmet (ECH) and a future Headborne System (HBS) that are designed to reduce the overall effects of battlefield kinetics, improvised explosive devices (IED), and to mitigate blunt impact. As evidence for mechanisms of blast injury develops, preventive measures to offset the damaging effects will be developed. Helmet sensors have been integrated into the current design to measure angular velocity and to determine the aggregate energy load over time that may cause mild traumatic brain injury (mTBI). Service members are natural risk takers. However, educational campaigns including operational risk management (ORM) serve to identify and minimize high risk behavior and encourage the use of personal protective equipment (PPE).

Early detection of injury is the cornerstone of TBI patient management. The accurate and timely diagnosis of moderate, severe, and penetrating TBI is typically not delayed due to the obvious and visible nature of the injury. Identification of mTBI, more commonly known as a concussion, presents a more difficult diagnosis due to its less obvious nature. Detection of mTBI relies upon identifying those Service members who may have sustained an injury and performing an initial evaluation, followed by clinician confirmation as needed. A systematic method for this process now exists in the area of operations (AO) in the form of the Military Acute Concussion Evaluation (MACE) tool. Established protocols for providers exist, in the form of the "Mild TBI Clinical Practice Guidelines (CPG) in the Deployed Setting" and in "Mild TBI Clinical Guidance" for

example. For those who may not be evaluated at the time of injury or while in-theater, TBI screening occurs at Landstuhl Regional Medical Center (LRMC) for all medically evacuated, during the Post-Deployment Health Assessment and Reassessment (PDHA/PDHRA) for all returning Service members, and upon entry into the Department of Veteran Affairs (VA) Healthcare System for retirees and/or separated Service members. The VA serves as a portal for re-evaluation and treatment after military service while also assisting in the care of active duty Service members.

Management of TBI within the Department of Defense (DoD) has made significant advances over the past several years. CPGs and clinical guidances have emerged to standardize the systems approach to treatment by incorporating state-of-the-art science, technology, and knowledge-based outcomes. The number of Service members with persistent symptoms from mTBI has demanded this coordination. A similar effort will address the co-morbidities associated with TBI such as depression and posttraumatic stress disorder (PTSD). Initiatives such as the Neurocognitive Assessment Tool (NCAT) initial baseline may help to improve return-to-duty determinations after injury. All Services have worked to enhance provider training that will greatly improve TBI patient management throughout DoD. The coordination of the TBI continuum of care between DoD and VA has increased significantly through the collaboration of the DVBIC TBI Care Coordination Network and the VA Polytrauma Federal Care Coordination System.

With 63,856 Service members receiving TBI diagnoses between January 2003 and September 2009, TBI has had not only a profound impact on our fighting force and their families, but also represents a significant healthcare cost.

Table 1. DoD Unique Cases by Service/Month

Month	Army (AD/Res/NG)	Marines (AD/Res)	Navy (AD/Res)	Air Force (AD/Res/NG)	Coast Guard (AD/Res)	Non-Mil (NATO/ CIV/FBI)	Missing/ Unknown	Grand Total
Jan 03 to Feb 09*	8490	2160	387	760	2	162	170	12131
Jan 08 to Dec 08**	16761	2648	2236	2077	372			24094
Jan 09**	1514	254	240	250	49			2307
Feb 09**	1074	108	71	104	8			1365
Mar 09	1622	206	170	185	16	11		2210
Apr 09	1498	321	260	249	31	11		2370
May 09	2389	471	393	464	79	2		3798
Jun 09	2800	459	380	395	79	4		4117
Jul 09	2998	412	314	344	48	10		4126
Aug 09	2522	340	266	335	49	5		3517
Sep 09	2757	367	305	330	53	9		3821
Total	44425	7746	5022	5493	786	214	170	63856

* Includes unique cases from DVBIC, Army, BUMED, and Air Force surveillance reports

** Includes unique cases from AFHSC (Armed Forces Health Surveillance Center) only

Mar 09 – Sep 09: Combined cases from all reports with duplications removed

This report summarizes the significant strides DoD, through the Services, has made in delivering care to its injured Service members, ranging from immediate care on the battlefield to long-term care at the home front. However, it will be DoD's leadership and collaborative efforts that embrace and enhance the primary concepts of prevention, accurate and timely diagnosis, and appropriate management and disposition that will help us more efficiently understand and address the multi-facets of TBI. Although Service-specific system approaches and cultures may differ, collectively we represent "One Team and One Fight" in addressing this issue. It is DoD's vision to ensure that the Service member, regardless of Service or location, who sustains a TBI receives the best care possible from accession to retirement, now and in the future.

2. Overview of Traumatic Brain Injury

TBI has been at the forefront of many health and force protection initiatives since the onset of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). Numerous reports have attempted to quantify the extent of TBI incidence and identify available resources. This report summarizes the overall DoD approach to TBI across the continuum, from injury to care to recovery and research in order to improve situational awareness of senior line and medical leaders. This report also begins to answer the fundamental question: "How are we caring of our wounded warriors with TBI?"

TBI Definition

A TBI is defined as a disruption of brain function resulting from a blow or a jolt to the head or a penetrating head injury. In October 2007, DoD established a formal definition of TBI as a "traumatically induced structural injury and/or physiologic disruption of brain function as a result of the external force." This injury is indicated by the new onset or worsening of at least one of the following immediately after the event:

- any period of or a decreased level of consciousness;
- any loss of memory for events immediately before or after the injury;
- any alteration of mental state at the time of injury (confusion, slowed thinking, etc);
- a focal neurological deficit (e.g. weakness, loss of balance, numbness, etc); or
- an intracranial lesion

DoD's definition is consistent with the TBI definition of other organizations to include the Center for Disease Control and Prevention (CDC), World Health Organization (WHO), American Academy of Neurology (AAN), the International Classification of Diseases (ICD) and the American Congress of Rehabilitation Medicine.

CDC estimates that 1.4 million people are treated for TBI in the United States annually. This figure does not include the vast majority who may have sustained a TBI and do not seek treatment. Between January 2003 and September 2009, 63,856 Service members have been identified within the DoD TBI Surveillance Database as having sustained a TBI, the majority of which were mTBI (otherwise known as concussion). It should be emphasized that approximately 85-90 percent of combat exposed troops who sustain mTBI have complete resolution of symptoms within the first several days to weeks.

TBI Severity

Table 2 describes the DoD criteria for assigning severity of brain injury. Moderate-severe and penetrating brain injuries typically are readily evident. However, mTBI may be overshadowed by other more severe injuries in the patient with multiple injuries. Still other Service members who experience an mTBI may minimize or discount their symptoms following an event and thus miss an opportunity for early diagnosis and possibly treatment. Current data show that mTBI comprises the vast majority of those sustaining combat-related TBI.

Table 2. TBI Severity

	Alteration of Consciousness	Loss of Consciousness	Post-Traumatic Amnesia	Structural Imaging
Mild	≤ 24 hrs	0-30 min	≤ 24 hrs	Normal
Moderate	> 24 hrs	> 30min But < 24 hrs	> 24 hrs But <7 days	Normal or Abnormal
Severe	> 24hrs	≥ 24 hrs	≥ 7 days	Normal or Abnormal

TBI Signs and Symptoms

The signs and symptoms of TBI can vary depending on the severity of the injury. It is important to understand that classification of severity of TBI is made at the time of the injury. This does not always correlate to the severity of ongoing symptoms or future functional impairment. Currently, there are no definitive medical treatments for the primary injury causing TBI. Secondary injury (i.e., effects of increased intracranial pressure) may be treated by aggressive acute management. Providers or clinicians may use pharmacologic and non-pharmacologic treatments to address symptoms following TBI.

The symptoms fall into three categories: somatic (e.g., headache, dizziness, weakness, sensitivity to light and sound), cognitive (i.e., difficulties with attention, memory, and language), and psychological/behavioral (i.e., irritability, depression, anxiety, personality

changes). Sleep disorders are common following TBI; inadequate sleep can exacerbate other symptoms, particularly problems with attention and irritability.

TBI Screening

Screening is the identification of people who may be at risk of having a specific disease or diagnosis. While a balance must be struck between over-identifying and under-identifying these people, the intent is to favor over-identification to ensure access to care. TBI screening is best completed closest to the time of injury; however, this may not always occur due to a variety of reasons (operational requirements, Service members not presenting for care, etc). For this reason, TBI screening occurs in two environments: deployed setting and non-deployed setting.

TBI Surveillance Methodology

Surveillance is defined as the monitoring of numbers of a specific disease once the diagnosis has been confirmed. DVBIC began collecting surveillance data on Service members who sustained a TBI in OIF/OEF in 2003. Data were obtained at DVBIC-affiliated sites, military medical treatment facilities (MTFs), VA, and civilian facilities. In 2007, the Assistant Secretary of Defense for Health Affairs directed expansion of TBI surveillance to include all components (Active duty, Reserve, and National Guard) of all the Services (Army, Navy, Marines, and Air Force) and to include all TBI (not just deployed force). DVBIC was designated as the Office of Responsibility for the consolidation of all TBI-related incidences and prevalence information for DoD.

There are 25 variables that are mandated for collection for every Service member who has sustained a TBI. The majority of variables for Service members who are seen at the various DVBIC sites are collected during their visits. Until 2008, this was the only method of collection for these data. Collaboration with TBI surveillance stakeholders such as CDC, Services, Armed Forces Health Surveillance Center (AFHSC), Force Health Protection and Readiness (FHP&R), Center for Health Promotion and Preventive Medicine (USCHPPM) began in 2009 to expand the capabilities of TBI surveillance. These efforts resulted in the standardization and implementation of TBI-related ICD-9 codes to be used for data mining. In January 2009, DVBIC received all 2008 TBI data from AFHSC, and continues to receive new data on a monthly basis for all of the Services.

Unlike data collected at DVBIC sites, these data points obtained through automated data pulls are incomplete. Efforts will need to be made to collect second and third tier variables through clinic notes to complete the dataset of each Service member. Quarterly updates of TBI numbers from this database are posted on the Military Health System (MHS) Web site.

TBI Continuum of Care in the DoD

The heterogeneity of TBI poses a myriad of challenges to the provision of care for Service members who sustain brain injuries. The diversity of sequelae following a brain injury means that the assignment of responsibility for care does not lend itself neatly to one particular medical specialty or clinical service. TBI care is an interdisciplinary endeavor that must incorporate and meld various clinical elements. The disciplines that comprise a comprehensive, integrated TBI treatment team include but are not limited to neurology, neurosurgery, psychiatry, neuropsychology, and physical medicine and rehabilitation. The list of ancillary services and therapies that are required to create a comprehensive team is much longer. The continuum of care for the treatment of TBI has many components, and patients follow different courses contingent upon their individual needs. The following paragraphs will begin to discuss the entry portals into this care continuum and some of the guidelines by which care is delivered.

PREVENTION → EARLY DETECTION → TREATMENT → REHABILITATION → RECOVERY → REINTEGRATION

3. TBI Prevention

Consistent with medical doctrine, prevention of the initial TBI injury is the most pragmatic and cost efficient course of action. Significant strides are being made to improve the PPE worn by our Service members. The Army and Marine Corps are aggressively working to improve today's helmet design. The Army Combat Helmet (ACH)/ Light Weight Helmet (LWH), is currently state-of-the-art PPE for TBI and was developed for use on today's battlefield. An improved version, the ECH is under development. The ECH will directly reduce the risks of modern era blunt impact projectiles, as well as promote theater specific ballistic protection. This modern helmet will be designed to stop the penetrating effects of small arms fire specific to the 7.62mm round.

Blast injury has emerged as the predominant cause of TBI in OIF and OEF, and has created the requirement for a new generation of combat helmet. The HBS, a joint Service future initiative, is being engineered as technology develops, with the primary goal of protection from blast injury.

The shell of the HBS supports the peripherals required to operate in today's combat environment. However, when combined with the primary features of the ECH, designed to reduce the primary effects of battlefield kinetics, will provide the Service members with the most effective piece of PPE available. Future considerations may be designed into the helmet to reduce the risk of TBI caused from non-kinetic sources, such as wave propagation. This theory suggests that barometric over-pressure may cause a concussive state, which with repeated exposure, could lead to non-kinetic induced mTBI.

An aggressive TBI prevention campaign has been launched by organizations such as the DCoE, the Army Safety Office and CDC. These organizations particularly emphasize the use of seatbelts, eye wear, and other forms of protective gear in various activities. It is this level of operational risk management that presents a common sense approach to TBI prevention, by empowering leadership to encourage safety controls at all levels, regardless of the operating environment.

4. Identification of TBI: Deployed Setting

Mild Traumatic Brain Injury

Early detection prompting appropriate treatment is the cornerstone for successful recovery. To that end, DoD has embarked on initiating a cultural change. The responsibility for force preservation lies with the leaders and the Service members themselves. Operational events, such as exposure to a blast within a certain distance or the presence of vehicular damage, now mandate a medical evaluation. This is similar to protocols seen in the aviation when a mishap occurs.

The MACE was developed by a committee of Service and civilian subject matter experts as a quick set of standardized TBI screening questions that can identify those Service members at high risk for possible TBI. Embedded in the MACE is a rapid screening tool for cognitive dysfunction, a brief neurological examination and a symptom checklist. Cognitive screening scores less than 25 are indicative of cognitive dysfunction and warrant further evaluation. However, this score does not diagnose a concussion. A clinician must confirm, either by patient self-reporting or by gathering of collateral information, the diagnosis of TBI. The MACE can be given by all medical personnel, including appropriately trained medics and corpsmen. A recent Army Office of the Surgeon General survey indicated that the MACE was frequently given in cases of suspected TBI and used in combination with other data when considering return to full duty. The Institute of Medicine Report on the Long-term Consequences of TBI (2008) stated that the MACE should continue to be used in the assessment of combat-related TBI. While the MACE has not been validated in austere environments, current studies are underway to address this.

Moderate to Severe Traumatic Brain Injury

Identification of moderate, severe, and penetrating TBIs is typically not delayed, due to the obvious nature of the injury. The Service members who have sustained these injuries are evacuated to higher echelons of care and treated. Screening in this population is usually not necessary because of the obvious neurological compromise that accompanies these injuries.

5. Identification of TBI: Non-deployed Setting

Mild Traumatic Brain Injury

Although the development of the MACE was meant to improve in-theater TBI care, it is a tool that can be used to screen for any acute (less than 72 hours from injury) concussion. Identifying Service members post-deployment and over a week after the injury event required a different methodology. Active efforts to screen Service members with possible TBI began asymmetrically in August 2003. DoD began screening initiatives for all Service members beginning in May 2008. DoD screening is intended to capture those Service members who may have sustained a TBI while deployed and perhaps have symptoms that require further assessment and treatment. Positive screens are not diagnostic of TBI but do trigger a clinician interview for further evaluation. TBI screening occurs at several time points and locations as outlined here:

- LRMC – all Service members evacuated from theater for battle or non-battle injuries and illnesses are screened upon arrival to LRMC. The main purpose is to identify co-morbid TBI in the context of polytrauma and to ensure proper transportation to an appropriate facility. (Began in May 2006);
- Post-deployment Health Assessment (PDHA) – all Service members returning from deployment answer a series of questions (questions 9 A-D) that report: a) exposure to injury event; b) presence of subsequent loss of consciousness or alterations in consciousness; c) presence of symptoms at time of injury; and d) presence of current symptoms. (Began DoD-wide in May 2008);
- Post-deployment Health Reassessment (PDHRA) – repeats questions from PDHA 90-180 days after return from deployment. (Began in May 2008); and
- Department of Veterans Affairs (VA) – any Service member entering the VA for any clinical care undergoes TBI screening identical to that of the PDHA with an instrument called the “TBI Clinical Reminder” (Began in April 2007).

The questions used in the PDHA, PDHRA, and VA’s TBI Clinical Reminder are an adaptation of an instrument called the “Brief TBI Screen (BTBIS).” This instrument has had preliminary validation published in peer-reviewed medical literature. These reviews were utilized by the White-House-appointed TBI External Advisory Committee to the Defense Health Board and the Institute of Medicine. These panels both recommended the use of the BTBIS. In December 2008, the Defense Health Board recommended continued use with minor modifications.

There are several important points to remember when reviewing data obtained from TBI screening. These numbers are derived from a self report screen and are not clinically confirmed diagnoses. A positive screen is identified when a Service member indicates concurrence to all four questions 9A-D (above) on the PDHA (DD2796) PDHRA

(DD2900). Questions A-D confirm all of the following: an injury event, symptoms after the injury and current on-going symptoms. Table 3 is the TBI screening data since the incorporation of the questions in May 2008 through March 5, 2009. A note should be made that these data include both combat-exposed and non-combat exposed Service members, but is limited to post-deployment Service members, not the entire DoD population. The chart below also does not include those Service members who may have answered positively to questions 9A/B or 9 A/B/C only, which may indicate that they sustained a concussion without current symptoms.

Table 3. TBI Screening Data

DD 2796 and DD 2900 Forms Completed (Jan 2008 versions with TBI Questions):			
Self reported screen			
	Total	Positive	% Positive
DoD	880,328	41,422	4.71%
Army	532,090	36,031	6.77%
Navy	54,143	889	1.64%
Air Force	193,723	1,399	0.72%
Marines	100,372	3,103	3.09%

Data Source: Defense Medical Surveillance System

Prepared by: Armed Forces Health Surveillance Center

Data through: September 15, 2009

When Service members screen positive for concussion, they need a confirmation evaluation to determine if they really did sustain a concussion. This evaluation should be conducted by a primary care provider using a structured interview to ascertain details of the injury event and the immediate post-injury mental status. This evaluation also elicits symptoms and the course of those symptoms. Service members who have persistent symptoms are started on treatment. Documentation in the electronic medical record is essential.

Given the polytrauma sustained by many of our combat warriors, the mandatory screening of all medically evacuated patients at LRMC helps to ensure that mTBI is not overlooked.

6. Management of TBI

In-Theater Management – Mild TBI

DVBIC convened a consensus conference in August 2008, to revise existing clinical practice guidelines (CPGs) for the evaluation and management of mTBI in-theater. The revised CPGs were staffed through the Joint Staff and subsequently adopted by the Joint

Theater Trauma System for use in all Combatant Commands. The CPG includes three algorithms: medic/corpsman, initial evaluation, and comprehensive evaluation. These are based on the type of providers and resources present. Recommendations include use of the MACE, indications for acute CT-scans, headache management, and evaluation for combat stress, duty limitations, and return to duty criteria. Symptomatic patients are now monitored and treated for up to fourteen days (or the discretion of the provider) in-theater. Most patients improve and remain on duty; however, those with persistent symptoms may be evacuated to LRMC for further intervention. In September 2009, another consensus conference was held to review this CPG. Additions include the defining of operational events that would mandate medical evaluation, a required rest period following involvement in one of these events and changes to the medical algorithms to address recurrent concussions.

North Atlantic Treaty Organization (NATO) countries have used DoD CPGs as a template for similar guidance and use in their military. NATO has recommended formation of an mTBI workgroup to consider adoption of a common NATO in-theater CPG.

The Gray Team, a February 2009 multi-service, in-theater evaluation team co-led by the Joint Staff and DVBIC, identified several areas to better improve application and utilization of both the MACE and the deployed CPG for management of concussion. These include expanding provider distribution of alternate versions of MACE available to limit memorization of cognitive screening questions, increasing utilization of electronic medical records and developing assessments to better inform return to duty determinations. Through the Gray Team recommendations, a neurologist has been established in-theater to serve as a TBI champion to consult on difficult cases.

An electronic consult service has also been established. In-theater providers who would like assistance with TBI management can send a de-identified email to tbi.consult@amedd.army.mil. Although an Army account is used, this service is open to providers from all Services. The consult is answered within four hours or sooner by a TBI expert.

In-Theater Management – Moderate, Severe and Penetrating TBI

There are several guidelines regarding the treatment of the more severe categories of TBI. Some of these include the Guidelines for Management of Severe TBI as published jointly by the Brain Trauma Foundation, the American Associations of Neurological Surgeons (AANS), Congress of Neurological Surgeons (CNS), and the AANS/CNS Joint Section on Neurotrauma and Critical Care, the Guidelines for Field Management of Combat Related Head Trauma as published by the Brain Trauma Foundation with support from DVBIC, and guidance regarding Prognosis in Penetrating Brain Injury as published by the Journal of Trauma Injury, Infection and Critical Care.

The robust trauma system of care provides rapid responses to this patient population, quick triage, and neurosurgical intervention when necessary. The cornerstone of first responder evaluation and treatment for this group is to prevent secondary brain injury by quickly addressing hypoxia (low blood oxygenation) and hypovolemia (low blood volume).

Neurocognitive Assessment Tool (NCAT)

In response to the National Defense Authorization Act (NDAA) for Fiscal Year 2008, baseline pre-deployment neurocognitive testing was started in May 2008 per direction of the Assistant Secretary of Defense for Health Affairs (ASD(HA)). The main objective of this program is to better inform return-to-duty (RTD) determinations in the field following a possible TBI. The capability to compare the baseline pre-injury neurocognitive scores (pre-deployment) with the post-injury scores can better inform and enhance the quality of clinical decision-making. The Army began to operationalize the Automated Neuropsychological Assessment Metrics (ANAM) program. DVBIC was named the office of responsibility for this project to facilitate multi-service collaboration and a Service workgroup was convened to establish protocols for implementation of this program. Using existing Army infrastructure, the ANAM Operations (ANAM OPS) office was formed. Equipment, staffing, and logistical support are currently provided under the auspices of ANAM OPS. The NCAT workgroup drafted implementation guidance and revises this guidance as the program evolves. As of October 2009, over 415,000 Service members have undergone baseline testing. DVBIC also has been involved in a number of studies/initiatives as directed by the OASD/HA to evaluate the efficacy of this program to better inform future decisions regarding implementation.

Non-Deployed Management – Mild TBI

In October 2007, the ASD(HA) adopted a Clinic Management Guidance algorithm developed by the Army Proponency Office for Rehabilitation and Reintegration (PR&R) with collaboration from DVBIC. In response to continued and frequent requests for assistance from primary care providers, DVBIC convened an interdisciplinary workgroup of DoD and civilian experts to establish guidance for the evaluation and management of concussion in CONUS. The revised guidance that resulted was staffed and implemented throughout DoD in May, 2008. This clinical guidance provided recommendations on the acute (up to seven days after injury) and subacute (between 7-90 days after injury) on the following:

- Assessment, to include symptom reporting;
- Imaging;
- Evaluation of visual, balance and hearing complaints;
- Specialty referral; and
- Duty restrictions.

Collaborative work groups of identified TBI experts from DoD and VA worked to develop a common CPG for CONUS management of patients with mTBI and presence of ongoing symptoms following injury. This resulted in the Management of Concussion/Mild Traumatic Brain Injury CPG by the VA/DoD Evidenced Based Practice Work Group that was released in April 2009. This CPG is meant to assist providers who are seeing patients with subacute (7-90 days) or chronic (greater than 90 days) symptomatic mTBI.

The intent of these CONUS guidelines is that injured Service members receive care in the primary care setting while remaining at their home duty stations. For those who fail initial management, referrals can be made to TBI specialists. These specialists may be located at TBI centers that have a higher allocation of resources and are better able to provide an integrative care approach than smaller military treatment facilities that lack specialty services and the expertise for treatment of complex co-morbidities.

Available interventions:

- Medication management;
- Vestibular rehabilitation;
- Vision therapy;
- Cognitive rehabilitation;
- Driving rehabilitation;
- Balance training;
- Life skills training;
- Assistive technology;
- Tinnitus management; and
- Complementary and alternative medicine interventions.

The core TBI therapies and interventions are the same throughout the Services. Pilot and research efforts in each of the above modalities are underway throughout the Department. Although these initiatives may create the impression that individual treatment locations differ significantly in their approach to TBI care, this is not the case. DCoE recently held a Cognitive Rehabilitation Consensus Conference, which resulted in standardized guidance to clinicians regarding this treatment for Service members with persistent cognitive symptoms from mTBI.

Non-Deployed Management – Moderate, Severe, and Penetrating TBI

The acute management of Service members who have sustained the more severe classification of TBIs occurs in-theater. Once returned to the United States, Service

members receive the care focused more heavily upon the rehabilitation and reintegration aspects. This care can occur at a variety of settings to include DoD TBI centers, the VA Polytrauma Rehabilitation Centers and civilian rehabilitation programs.

An overall goal for DoD TBI identification and management is to enhance individual care and ensure the highest level of care for all Service members with TBI. Tracking the outcomes of DoD wounded and remaining flexible enough to adjust treatments and care delivery mechanisms will ensure that this mission is successful.

7. TBI Educational Initiatives

Provider Training

In September 2007, DVBIC began hosting an annual conference covering the spectrum of TBI assessment and care. Each event was attended by more than 800 DoD medical personnel. The third annual conference is scheduled for September 2009. DVBIC has a network of 11 education coordinators positioned throughout the country to provide ongoing year-round support to providers, line Commands, patients, and families. Additional pre-deployment provider training is completed at the Combat Casualty Care Course (C4).

PR&R is developing a series of TBI educational modules that will be required for providers of different skill levels. These modules will be accessible via MHS Learn in the near future. TBI centers also provide training at varying levels. For example, Brooke Army Medical Center, Great Plains Regional Medical Center and the VA co-host monthly nationwide video conferences on TBI related topics.

The Air Force has been involved with several educational efforts including: 1) the Joint Blast Concussion Injury Conference held in collaboration with Army and Navy which trained medics and Corpsmen on identification and assessment of TBI; 2) the Expeditionary Medical Support (EMEDS) training (AFMC; USAFSAM/AFEMSI), which provides added TBI training to all medics attending pre-deployment EMEDS training; 3) TBI Clinical Practice Guideline training to AFMS MH providers at Operational Problems in Behavioral Science Symposium in July 2008; 4) participation in DoD Behavioral Health Optimization Program work group developing protocols and practice guidelines for TBI assessment in primary care; 5) Joint ANAM/TBI training, to include Army and Air Force psychologists, began in January 2009 and 6) in collaboration with DVBIC, the Air Force Center of Excellence for Medical Multimedia has created an educational website for providers and patients located at www.traumaticbraininjuryatoz.org.

The Navy has established a training program on concussion management and ANAM for psychologists and psychology technicians and is in the process of implementing a training program to provide medical personnel hands-on training to administer the

MACE. A training program for primary care providers and deploying medical personnel on concussion management is in development.

Patient and Family Education

Official DVBIC and DoD educational materials have been developed with an expert on risk communication with reinforcement of positive expectations after TBI. A review by the RAND Corporation praised these materials for their clinical accuracy and appropriate risk communication.

In addition to their provider modules, PR&R is developing TBI educational modules that are appropriate for all Service members. Efforts to include Service members of all branches in this project were made so that the modules can be used throughout DoD. The PR&R office convened numerous panels of SMEs to develop standardized patient information. Included are self-help brochures on sleep hygiene, headaches, dizziness and other post-concussive symptoms. This material has been developed and funded by the Army with collaboration from the other Service branches, thus making these materials available to all of DoD.

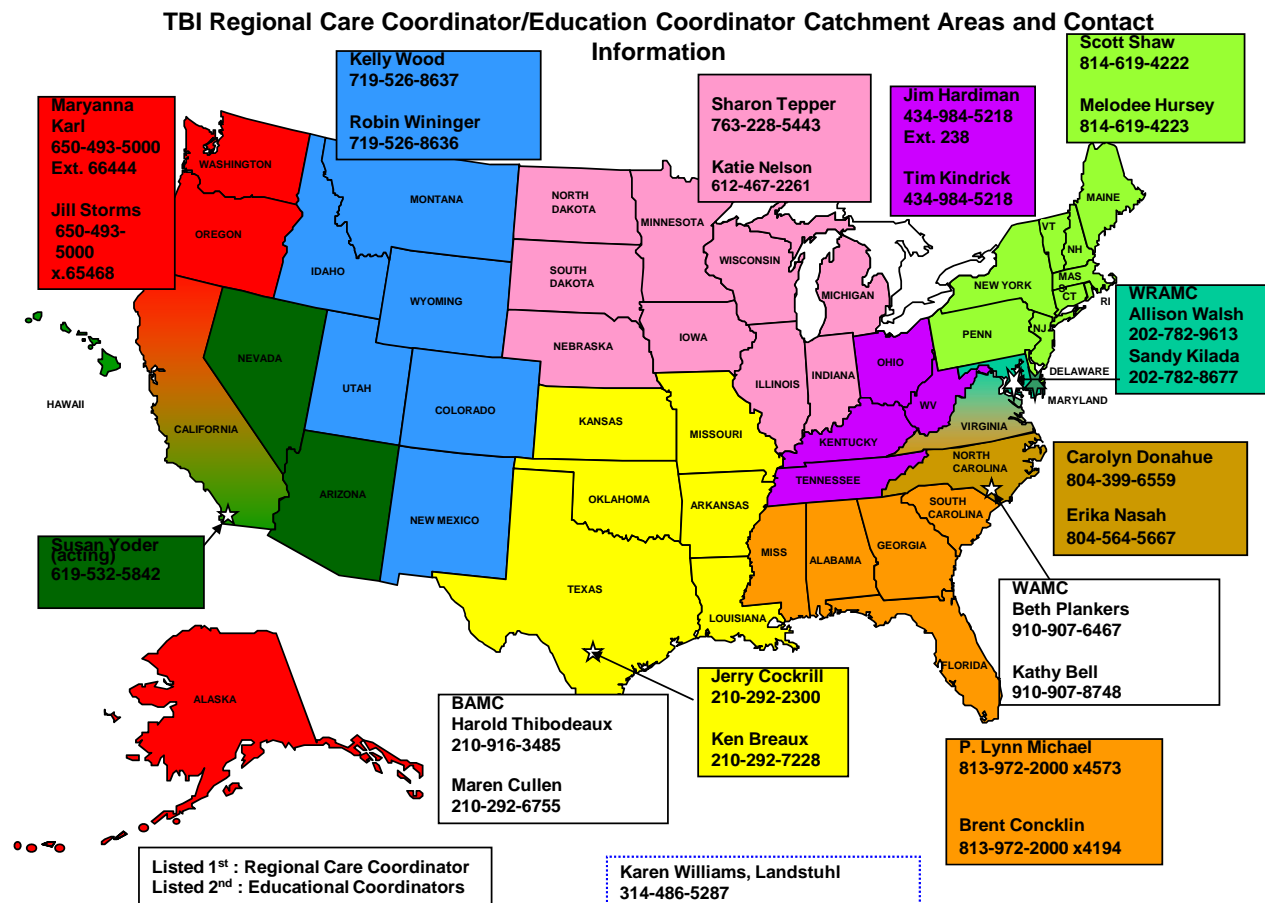
To address the needs of family members of Service members with TBI, Congress mandated the development of a Family Caregiver Curriculum. DVBIC is coordinating this initiative, which is assisted by a White-House-appointed panel of experts. Collaboration is ongoing with DoD's only Center of Excellence for Medical Multimedia. In addition, DVBIC has utilized social networking to help connect family members together who have gone through similar experiences with having a loved one sustain a TBI. The curricula will be ready for dissemination by December 31, 2009.

Care Coordination

A nationwide care coordination network (Table 4) has been established by DVBIC for those diagnosed with TBI. The program currently identifies all Service members diagnosed with TBI who are medically evacuated from theater. A care coordinator contacts the Service member once they reach CONUS, and again at 3, 6, 12, and 24 months following injury. During these contacts, assessments are made to determine what, if any resources may be appropriate in addition to a standardized interview questions that inquire about substance use, relationships, readjustment after deployment and other areas shown to be important to follow-up in a patient that has sustained a TBI. If indicated, the care coordinator can provide a listing of local resources to the injured warrior. This program has served as primary TBI resource to other broader care coordination systems such as the VA Polytrauma Federal Care Coordination system. The program has expanded to include 11 regions across the country and in Germany as illustrated in the figure below. DCoE's Outreach Center (866-966-1020), provides 24/7 support to patients, family members, providers, and Command is the link that can

network all of the different stakeholders with the appropriate resources.

Table 4. TBI Regional Care Coordination/Education Coordination Catchment Areas and Contact Information



8. External Evaluation and Recommendations

Institute of Medicine Report on Long Term Effects of TBI (2008)

This Institute of Medicine report released in December 2008 was reassuring that the DoD is on a proper trajectory regarding management of TBI. A summary of the recommendations and correlating initiatives is presented below.

IOM Recommendation	DoD Contribution to Recommendation
The committee recommends that DoD use the Brief Traumatic Brain Injury Screen and the Military Acute Concussion Evaluation for every soldier who has a history of blast exposure (even of low-intensity blast exposure).	BTBIS and MACE developed & validated by DVBIC BTBIS has been adapted and is now included in PDHA and VA TBI Screens. MACE is widely distributed throughout theater. OTSG provider survey indicates good use of tool in concussion evaluation
The committee recommends that DoD and VA support prospective, longitudinal studies to confirm reports of long-term or latent effects of exposure to blasts. Those studies should examine the consequences of blast-induced neurotrauma, recovery timeline, and any factors that improve or worsen outcomes.	DVBIC designated as executive agent for Congressionally Mandated 15 Year Longitudinal Study of TBI DVBIC is the Office of Responsibility for the TBI Registry
The committee recommends that DoD and the Department of Veterans Affairs support research on animal models of blast-induced neurotrauma.	DOD working collaboratively with several agencies on the following blast studies: <ul style="list-style-type: none"> • DVBIC in conjunction with AFIP have developed a TBI research center that will have the ability to facilitate animal model research and translational research with particular emphasis on the neurobiology of blast injury; • Helmet sensor study; • DARPA PREVENT; • DARPA/Office of Naval Research (ONR) Breachers study; • DVBIC Blast TBI Imaging Study (Acute); • ONR initiatives; • AFRL initiative on enriched environments; • Congressionally Directed Medical Research Program (CDMRP) initiatives; and • Medical Research Military Command (MRMC) initiatives
IOM Recommendation	DoD Contribution to Recommendation
The committee recommends that VA include, in the development of TBI Veterans Health Registry (hereafter referred to as “the registry”), other Service members who could provide a valid comparison for the analysis of outcomes. Comparison groups should be made up of injured persons without traumatic brain injury or blast exposure, uninjured deployed veterans, and uninjured non-deployed but previously active-duty veterans.	DVBIC named as primary DoD collaborator on the VA Registry and is contributing to its development.
In an effort to understand the long-term outcomes TBI, including consequences that might be related to blast, the committee recommends that all deployed military personnel undergo pre-deployment neurocognitive testing. The committee also recommends post-deployment neurocognitive testing of representative samples of military	<ul style="list-style-type: none"> • DVBIC Office of Responsibility for Pre-deployment Neurocognitive testing. ANAM Ops logistically responsible for testing; • DVBIC conducting post-deployment neurocognitive studies; and • OSD/HA designated DVBIC as office of responsibility to perform independent Head to Head

IOM Recommendation	DoD Contribution to Recommendation
personnel (including those with traumatic brain injury, those with other non-TBI injuries, and uninjured Service members without blast exposure.	Study of Automated Neurocognitive Tests

9. Selected Research and Pilot Work

Blast and Other Combat Related Brain Injury

The short and long term effects of blast injury on the brain are still unknown. In an effort to further understand the patterns of this injury, the DoD is collaborating with numerous other agencies on translational biophysics, proteomics, and other blast-related projects. Current and future studies include:

- A Helmet Mounted Sensor Study- Sensors to be placed in the LWH/HBS to measure the energy load received by the helmet when in proximity or direct contact of an Improvised Explosive Device;
- DARPA/ONR Breachers Study – Evaluating a possible decrement in ANAM performance among instructors following several days of controlled blast exposure;
- Complications of TBI – imaging findings related to blast- Diffusion Tensor Imaging Study, Pituitary Dysfunction, and Auditory Dysfunction;
- 15-year longitudinal study – Sponsored through DVBIC, this study will examine the long-term effects and outcomes of combat-related TBI;
- DARPA PREVENT – Recently identified inflammation in brain in absence of neuronal damage in lower grade exposures;
- Massachusetts Institute of Technology (MIT) Institute of Soldier Nanotechnology and DVBIC Collaboration – Developed most sophisticated computer model of blast and brain interactions;
- DVBIC/AFIP Traumatic Brain Injury Research Center– Equipped for state-of-the-art pre-clinical studies with advanced imaging and CARS microscopy which will allow for in vivo assessment of blast effects on brain;
- The DoD Blast Injury Research Program Coordinating Office hosted a three day meeting May 12-14, 2009, of approximately 80 subject matter experts to help understand non-impact blast-induced mTBI. Based upon the information presented at this meeting, it was concluded that non-impact, blast-induced mild trauma of the brain can occur; however, the mechanism(s) is unknown and

there are limitations to laboratory research due to the lack of knowledge of real-world exposure conditions; and

- Hyperbaric Oxygen 2 (see below).

The Blast Detectors are in use by the Army and Marine Corps to measure the Angular Velocity (Blast Dosimetry) aggregate load over time of an improvised explosive device (IED) event(s). These sensors, the MedEng and BAE Systems, have different methods of measuring and storing data, and downloading this information to a deployable laptop for future analysis. It is hoped that this information can be directly correlated to the Service members to better understand the effects of blast energy. Currently, 30,000+ Soldiers and 2,000 Marines have been outfitted with these sensors. A future long term epidemiology study may be developed to correlate the data between the ANAM (multiple data points) and the Blast Sensors.

DCoE is working with the Services to sponsor a study to evaluate the safety and efficacy of hyperbaric oxygen in the treatment of chronic symptomatic mild to moderate TBI. This study will be a prospective, randomized, double-blind, sham comparator trial that will enroll approximately 300 subjects. Outcome measures to be evaluated include symptom improvement, functional improvement, neuroimaging, and visual/vestibular and auditory measures.

An area of future exploration is the completion of more in-theater research protocols. While this can provide significant data that is not easily available by other mechanisms or not reproducible in CONUS, the safety of the warfighter and the integrity of the overall mission remain our highest priority.

10. Service Specific Initiatives

Below is a partial list of some of the major Service-specific initiatives regarding TBI. These are some of the solutions that Services have developed to address together the prior gaps in TBI care.

Army TBI Programs

The Army Medical Command published an Operation Order to guide development of TBI programs. The Office of the Surgeon General (OTSG), in collaboration with DVBIC, established a validation program for all Army Medical Department (AMEDD) Medical Treatment Facilities providing care for patients TBI. This validation program establishes standards of care to ensure that services, physical facilities, equipment, and staffing levels are consistent and sufficient across the Army MTFs based on the level of care provided by that facility. Program reviews are conducted to evaluate compliance with validation criteria. (See Table 5).

-
- Category 1- inpatient and outpatient care for the full spectrum of TBI severity;
 - Category 2- inpatient and outpatient care for mild and moderate TBI;
 - Category 3- outpatient medical and rehabilitative care for those with mild-moderate TBI; and
 - Category 4- outpatient medical care for mTBI. Refers additional services as needed.

The OTSG is also creating a data collection and documentation tool for primary care providers, developing a network of tele-health care for patients with TBI, piloting a cell phone text messaging project, supporting equipment purchase to enhance quality of care, developing educational materials for a wide variety of audiences, and promoting the TBI program to professional organizations

Navy and Marine Corps TBI Programs

The Department of the Navy and the Marine Corps are working to strategically develop TBI assets in high utilization areas. The National Naval Medical Center has opened a seven-bed in-patient ward for sub-acute to chronic TBI patients. Naval Medical Center San Diego has the C5 polytrauma center and the Naval Center for Combat Operational Stress. Naval Medical Center Portsmouth has the Traumatic Brain Injury and Related Disorders (TBIRD) multidisciplinary clinic. Development of a TBI center is planned for Camp Lejeune. Camp Pendleton is the site of the Office of Neurotrauma for Navy Medicine West. Navy medicine is also focused on additional TBI resources for Naval Hospital Okinawa and Marine units in Hawaii. Other initiatives include institution of a pilot program to conduct post-deployment neurocognitive screening for Service members with missions that elevate their risk of concussion or exposure to blast. Navy Medicine is also developing a hand-held neurocognitive testing system, called Braincheckers, to use in the field to evaluate Service members for cognitive impairment after blast or concussion. There has also been an in-theater study of vestibular symptoms associated with blast/concussion. The Naval Medical Research Center and Naval Health Research Center have ongoing basic science and clinical TBI research programs. The Bureau of Medicine and Surgery has developed a care for caregivers program and a combat operational stress control program.

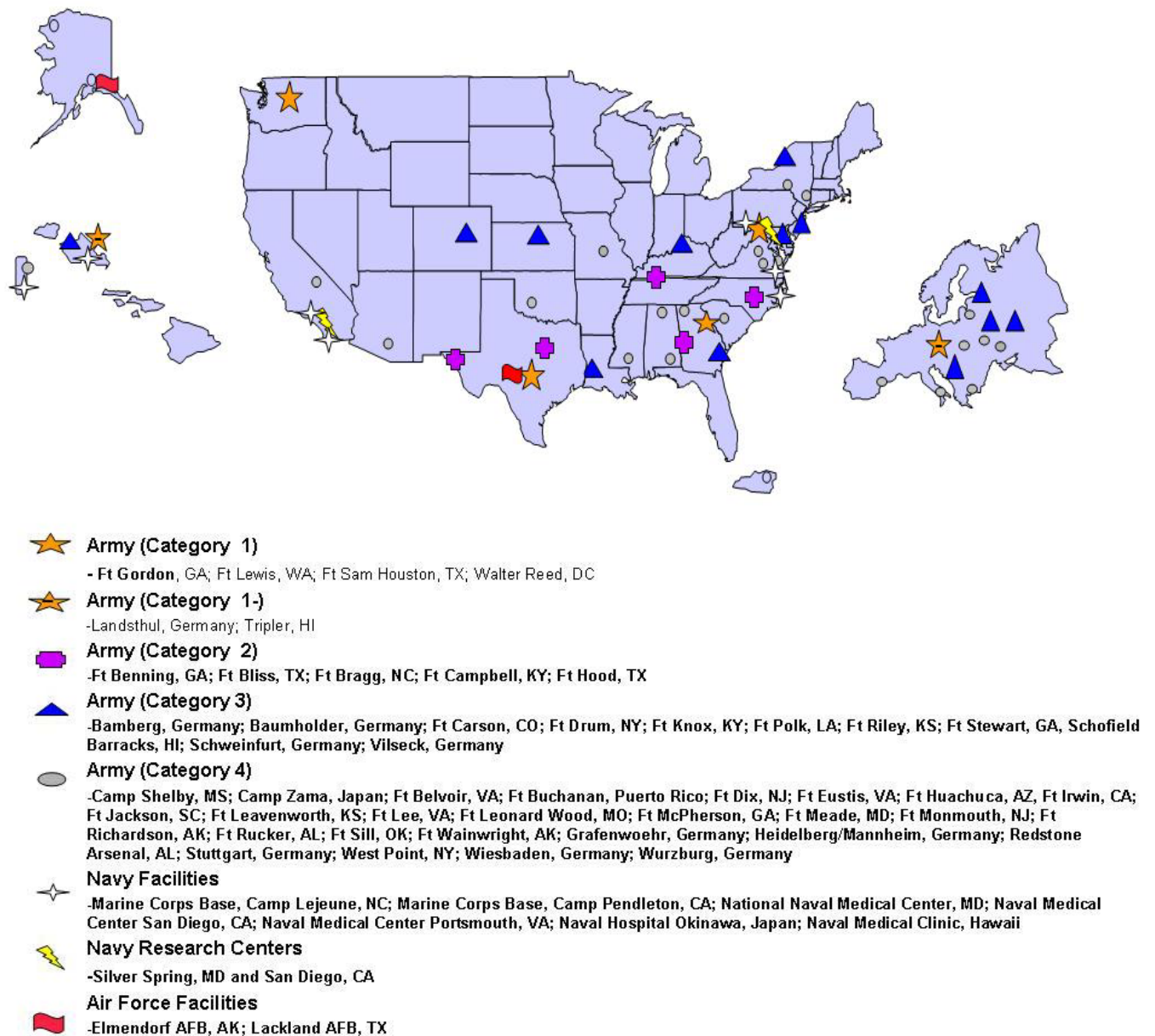
Air Force TBI Programs

The Air Force is the lead agency in formulating responses to complex medical problems involved in air transport of acute care TBI patients. At the forefront of that effort is the Air Force's Critical Care Air Transport Teams (CCATT). This initiative has led to countless lives saved. The Air Force works to continuously improve this capability, reviewing information from databases such as the Joint Theater Trauma System (JTTR) and incorporating lessons learned. In-theater cognitive assessment of TBI is performed at the Air Force Theater Hospital (CENTAF; 332nd MDG) at Balad, Iraq and elsewhere

in the Area of Responsibility (AOR). In CONUS, Wilford Hall Medical Center at Lackland AFB provides clinical support to Brooke Army Medical Center to ensure comprehensive integrative TBI care to medically evacuated Wounded Warriors. The joint AF/Army TBI Clinic at Elmendorf AFB treats TBI/PTSD in redeployed members so that returning OIF/OEF Service members may remain with their loved ones while receiving care.

Table 5. Traumatic Brain Injury Programs

As of 15 June 2009



11. Recommendations for the Way Ahead and Summary

Recommendations for the Way Ahead

- Recommend development of a comprehensive DoD-wide TBI program that embraces identified core components (screening, assessment, treatment, education, patient identification and follow-up) while acknowledging the different Service cultural needs and the different capability needs based on the population and the mission served.
- Recommend development of a standardized DoD approach to evaluation of critical elements within TBI programs to ensure that quality care is being provided. Critical elements should include guidelines on: Time from time of injury to time of evaluation; Time from referral for care to appointment; Rate of patients with symptom resolution; Treatment coordination with Line Command, including Personnel functions.

Summary

This brief summary of the ongoing DoD efforts related to TBI demonstrates a comprehensive approach to this condition along the entire continuum from Prevention through Recovery and on to Reintegration. Programs continue to evolve as information about leading practices and the results of studies and pilots become available. Continued development of a coordinated DoD TBI approach that is centered around the primary concepts of prevention, accurate and timely diagnosis, and appropriate management and disposition will ultimately ensure that the injured Service members, regardless of Service or location, receives the best care possible, now and in the future.

Contributors

Dr. Douglas Gibson (USAF), Ms. Katherine Helmick (DCoE), Col Michael Jaffee (DVBIC), CDR Frederick Kass (USMC), Dr. James Kelly (NICoE), LTC Lynne Lowe (USA), Dr. Maria Mouratidis (USN), Ms. Janet Papazis (USA), Ms. Cindy Petit (USAF), LCDR Stephen Popielarz (USMC), CDR Jack Tsao (USN), Maj Megumi Vogt (DCoE), Col Christopher Williams (DCoE)